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Un Nyoung SA et al.	)	Confirmation No. 3831
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Filed: September 30, 2003	)	Examiner: T. Nguyen
	)	
For: LIQUID CRYSTAL DISPLAY DEVICE AND METHOD OF FABRICATING THE SAME	)	**Mail Stop AMENDMENT**

Commissioner for Patents
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The document for which the attached English translation is being submitted is the Korean Patent Application No. 2002-0066787 filed in Korea on October 31, 2002. The Korean language document was filed in the U.S. Patent and Trademark Office on September 30, 2003.

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Date: June 25, 2007

【TITLE OF THE DOCUMENT】PATENT APPLICATION

【KIND OF RIGHT】PATENT

【TO】COMMISSIONER

【FILING DATE】October 31, 2002

【TITLE OF THE INVENTION】 DEVICE AND FABRICATION METHOD FOR RETARDATION FILM IN SUBSTRATE OF LCD

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【PURPOSE】 The present application is filed pursuant to Article 42 of the Korea Patent Act.

Patent Attorney : Young Nok HAW

【ABSTRACT】

【Abstract】

The present invention discloses a liquid crystal display device with a compensation film in inner side of substrate and fabricating method thereof.

[0017] The method for fabricating the liquid crystal display device includes: forming a gate line and a gate electrode on a transparent insulating substrate by coating process of a gate metal film; forming sequentially a gate insulating film, an active layer, an ohmic contact layer, source and drain electrodes, and a data line on the transparent insulating substrate; coating a passivation film for a element protection on the transparent insulating substrate including the source and drain electrodes and the data line; forming a compensation film on the passivation film; and forming a ITO pixel electrode on the compensation film.

Because the compensation film is formed in inner side of substrate through a depositing process, the LCD device and fabricating method thereof according to the present invention allow the thickness of the LCD device to decrease.

【Representative drawing】

Figure 3

【Representative drawing】

Compensation film, Thin film transistor, color filter

【SPECIFICATION】

【Title of the invention】

LIQUID CRYSTAL DISPLAY DEVICE WITH A COMPENSATION FILM IN INNER SIDE OF SUBSTRATE AND FABRICATION METHOD THEREOF

【Brief description of the drawings】

[0001] FIG. 1 is a view of a structure of a first substrate (a TFT substrate) according to the related art;

[0002] FIG. 2 is a view of a structure of a second substrate (a color filter substrate) according to the related art;

[0003] FIG. 3 is a view of a structure of a TFT substrate according to the present invention;

[0004] FIGs. 4a to 4e are views a method for fabricating a first substrate (a TFT substrate according to the present invention within a compensation film;

[0005] FIG. 5 is a view of a structure of a color filter substrate (C/F) according to the present invention;

[0006] FIGs. 6a to 6d are views of a method of a first embodiment for fabricating a color filter substrate of a liquid crystal display device with a compensation film in its substrate according the present invention; and

[0007] FIG. 7 is a view of a method of a second embodiment for fabricating a color filter substrate of a liquid crystal display device with a compensation film in its substrate according the present invention.

[0008] <Description of the marks for principal potions in the drawings>

[0009] 301 --- first substrate 302 --- gate electrode

[0010] 303 --- gate insulating film 304a, 304b --- active layer, ohmic contact layer

[0011] 305,310 --- source/drain electrode 306 --- data bus line

[0012] 307 --- passivation film 308 --- compensation film

[0013] 309 --- pixel electrode 501 --- second substrate

[0014] 502 --- black matrix 503 --- color filter

[0015] 504 --- compensation film 505 --- common electrode

[0016] 506 --- overcoat film

【Detailed description of the invention】

【Object of the invention】

【Technical field including the invention and prior art therein】

[0018] The present invention relates to a compensation film of a liquid crystal display device, and more particularly, to a liquid crystal display device of a reduced profile having a compensation film, which is deposited on a thin film transistor substrate and a color filter substrate, and a method of fabricating the same.

[0019] In general, a liquid crystal display (LCD) device includes a first substrate (a thin film transistor substrate) and a second substrate (color filter substrate) opposite to each other in a constant distance. In detail, in the LCD device, the first substrate (the thin film transistor substrate) of the LCD device includes gate bus lines and data bus lines which are formed in a matrix on the inner surface of a transparent substrate.

[0020] Thin film transistors (TFTs) function as switching devices and are formed at intersections between the gate bus lines and the data bus lines. Rectangular pixel

electrodes contacted the drain electrodes of the TFTs are formed in regions defined by the gate bus lines and the data bus lines, respectively.

[0021] The second substrate (color filter substrate) opposite to the transparent substrate with a plurality of the pixel electrodes includes a black matrix, a color filter layer and a common electrode formed on the other transparent substrate.

[0022] In the LCD device configured as the above, when voltages are supplied to one gate bus line and one data bus line the TFT disposed at the intersections between the gate lines and the data lines to which the voltage is supplied, are turned on. Then, charges are accumulated in the pixel electrode connected with the drains of the turned-on TFT, thereby changing the orientation of liquid crystal molecules between the pixel electrode and the common electrode.

[0023] FIG. 1 is a view of the first substrate (TFT substrate) according to the related art. In FIG. 1, a gate electrode 102 is formed on a transparent substrate 101, and a gate insulating film 103 is grown on the gate electrode 102 by a plasma enhanced chemical vapor deposition (PECVD).

[0024] Next, an amorphous silicon layer and an phosphorous-doped amorphous silicon layer are sequentially deposited and patterned using photolithographic processes to form a channel layer 104 that includes an active layer 104a and an ohmic contact layer 104b.

[0025] A metal layer is deposited on the channel layer 104 including the active layer 104a and the ohmic contact layer 104b, and is patterned by a etching process using a source/drain mask to form source/drain electrodes 105 and 110.

[0026] Then, a passivation film 106 of an inorganic material is formed on the substrate, and a pixel electrode 107 of an indium titan oxide (ITO) is formed on the passivation film 106.

[0027] FIG. 2 is a view showing a structure of the second substrate (the color filter substrate) according to the related art. Method of fabricating the second substrate (the color filter substrate can use a dying process, a dye dispersion process, a pigment dispersion process, and an upset process, wherein the method of fabricating the second substrate (the color filter substrate) may use the pigment dispersion method.

[0028] As shown in FIG. 2, a photoresist film containing carbon black and titanium oxide, which have a light-shielding property, is coated on a transparent substrate 201. The photoresist film are exposed to light through a mask to form a predetermined pattern. Then, the photoresist film is developed along with the exposed pattern. The developed photoresist film is are hardened to form the black matrix 202.

[0029] Then, a photoresist film of azo-based red pigment is coated on the substrate and is exposed to light through a mask to form a predetermined pattern.

[0030] The photoresist film is developed along with the exposed pattern and the developed photoresist film is hardened, thereby forming red color filters.

[0031] Next, a photoresist film of phthalocyanine-based green pigment is coated on the substrate on which the red color filters are formed, and is exposed to light through a mask to form a predetermined pattern. The photoresist film is developed along with the exposed pattern and the developed photoresist film is hardened, thereby forming green color filters.

[0032] Furthermore, a photoresist film of phthalocyanine-based blue pigment is coated, exposed, developed and hardened on the transparent substrate, thereby forming blue color filters. As a result, a process of forming a color filter layer 203 is completed.

[0033] Next, a transparent conductive film, such as ITO, is deposited on an entire surface of the substrate to form a common electrode 204.

[0034] The first substrate (TFT substrate) and the second substrate (color filter substrate) are sequentially in the processes of cleansing, forming an alignment film for an orientation of liquid crystal molecules, and rubbing for orientating the liquid crystal in a constant direction. The first and second substrates are bonded to each other to have a constant cell gap. The liquid crystal material is injected between the bonded substrates. Compensation films are deposited on both faces of the bonded substrates.

[0035] Meanwhile, liquid crystal molecules injected between the first substrate (TFT substrate) and the second substrate (color filter substrate) have a birefringence, wherein a refractive index of a long axis of the liquid crystal molecules is different from a short

axis of the liquid crystal molecules. Due to this birefringence, viewing angles are changed according to a position of a viewer.

[0036] The changing of the viewing angle results from that a polarization state of linearly polarized light changes when the light passes through the crystal liquid material. Accordingly, when the LCD is viewed from a front side or a lateral side, the amount of light and color characteristics of the displayed image are changed. Thus, the liquid crystal display device causes brightness, contrast ratio, color shift, and gray inversion to occur depending on the viewing angles.

[0037] As methods for expanding the view angle of the LCD device, there are used techniques of a multi-domain, a phase compensating, a IPS (In Plane Switch) mode, a vertical alignment mode, a light path controlling, and so on. The multi-domain method divides one pixel into a plurality of regions and enables the orientation of the liquid crystal molecules to be different along with the regions, thereby allowing the characteristic of the pixel to have an average of the characteristics of the regions. The phase compensating method uses a phase differentiation film to reduce a variation of the

phase differentiation in accordance with changing of the viewing angle. The LCD device of the IPS mode applies a lateral electric filed to the liquid crystal material and enables the directional pole of the liquid crystal to be twisted in a plane parallel with an alignment film. The LCD device of the vertical alignment mode uses a liquid crystal material having a negative dielectric anisotrophy. The method of controlling light paths enables lights from a backlight unit to prograss in a direction perpendicular to a liquid crystal cell and to spread at in a light detection plate in various directions.

[0038] Among the proposed solutions to the adverse changes of the view characteristics, it will be exemplarily described a LCD device using the phase compensation method which reduces the variation of the phase differentiation in accordance with the changing of the viewing angle.

[0039] In order to compensate a phase differentiation generating in the liquid crystal material, compensation films 108 and 205 are further formed on the exposed surfaces of the first and second substrates. The compensation films 108 and 205 compensate the phase variations in the liquid crystal material in opposite directions to the phase

variations, thereby eliminating the viewing angle problem. The compensation films 108 and 205 may include a uniaxial or biaxial film.

[0040] However, foreign particles may be interposed between the compensation films 108 and 205 and the first substrate (TFT substrate) and/or the second substrate (color filter substrate) when the compensation films 108 and 205 are disposed on outer surfaces of the first and second substrates. In this case, the foreign particles complicate the fabricating process since the compensation films must be removed, the foreign particles are cleaned from the substrates, and then the substrates are reattached to the outer surfaces of the substrates.

[0041] Moreover, the compensation films attached to the outer surfaces of the TFT substrate and the color filter substrate increase an overall thickness of the LCD device.

【Technical subject matter to be solved by the invention】

[0042] As invented for obviating one or more problems due to limitations and disadvantages of the related art, an object of the present invention is to provide a liquid

crystal display device with a compensation film which is formed in at least one of a color filter substrate and a TFT substrate, reducing its profile, and fabricating method thereof.

【Configuration and operation of the invention】

[0043] In an aspect to achieve the object of the present invention, a liquid crystal display device includes:

[0044] a gate line and a gate electrode formed on a transparent insulating substrate by coating process of a gate metal film;

[0045] a gate insulating film, an active layer, an ohmic contact layer, source and drain electrodes, and a data line formed sequentially on the transparent insulating substrate;

[0046] a passivation film formed on the transparent insulating substrate including the source and drain electrodes and the data line;

[0047] a compensation film formed on the passivation film; and

[0048] a ITO pixel electrode formed on the compensation film.

[0049] In another aspect to achieve the object of the present invention, a fabricating method of the liquid crystal display device includes:

[0050] forming a gate line and a gate electrode on a transparent insulating substrate by coating process of a gate metal film;

[0051] forming sequentially a gate insulating film, an active layer, an ohmic contact layer, source and drain electrodes, and a data line on the transparent insulating substrate;

[0052] coating a passivation film for a element protection on the transparent insulating substrate including the source and drain electrodes and the data line;

[0053] forming a compensation film on the passivation film; and

[0054] forming a ITO pixel electrode on the compensation film.

[0055] In still another aspect to achieve the object of the present invention, a liquid crystal display device includes:

[0056] a black matrix formed on a transparent insulating substrate;

[0057] a color filter layer, which has red, green and blue colors, formed on the black matrix through sequential coating, exposing and developing for each of red, green and blue colors;

[0058] a compensation film formed on the color filter layer; and

[0059] a common electrode formed on the compensation film by a depositing process of ITO metal film.

[0060] The fabricating method further includes a overcoat layer formed on the substrate with the color filter layer.

[0061] In further still another aspect to achieve the object of the present invention, a fabricating method of a liquid crystal display device includes:

[0062] forming a black matrix on a transparent insulating substrate;

[0063] forming red, green and blue color layers on the black matrix by a process of sequential coating, exposing and developing for each of red, green and blue color layers,

[0064] forming a compensation film on an upper surface of the red, green and blue color layer; and

[0065] forming a common electrode on the compensation film through a process of depositing a ITO metal film.

[0066] The fabricating method further includes forming a overcoat layer on the substrate with the color filter layer.

[0067] According to the present invention, since the compensation film is deposited in the inner side of at least one of the TFT substrate and the color filter substrate, the LCD device has a reduced profile.

[0068] Reference will now be made in detail to a preferred embodiment of the present invention with reference to the attached drawings.

[0069] FIG. 3 is a view showing a structure of an exemplary TFT substrate according to the present invention. In FIG. 3, a TFT substrate may include a transparent insulating substrate 301, a gate line (not shown) and a gate electrode 302 that may be formed by depositing a metal film on the transparent insulating film 301, a gate insulating film 303, an active layer 304a, an ohmic contact layer 304b, source and drain electrodes 305 and 310, and a data line 306. In addition, a passivation film 307 may be deposited on the source/drain electrodes 305 and 310 and the data line 306 to provide protection, a compensation film 308 may be formed on an upper surface of the passivation film 307, and an ITO pixel electrode 309 may be formed on the compensation film 308.

[0070] A fabrication method of a LCD device with a compensation film in inner side of a substrate in accordance with the present invention, in association with FIG. 3, will be described.

[0071] FIGs. 4a to 4e are views showing processes for fabricating a first substrate (a TFT substrate) according to the present invention. In FIG. 4a, a gate metal film may be deposited on a transparent insulating film 301 to form a gate line (not shown) and a gate electrode 302 that branches from the gate line.(S401)

[0072] As shown in FIG. 4b, a gate insulating film 303, an active layer 341, an ohmic contact layer 342, source/drain electrodes 305 and 310, and a data line 306 may be sequentially formed on the TFT substrate including the gate line (not shown) and the gate electrode 302.(S402)

[0073] In detail, the gate insulating film 303 may be deposited on the gate line (not shown) and the gate electrode 302 by a plasma enhanced chemical vapor deposition (PECVD). Then, an amorphous silicon layer and a phosphorous-doped amorphous silicon layer may be sequentially deposited on the gate insulating film 303. Next, the

deposited amorphous silicon layer and phosphorous-doped amorphous silicon layer may be patterned using photolithographic processes, thereby forming a channel layer 304 of the active layer 304a between portions of the ohmic contact layers 304b.

[0074] Next, a metal film for source and drain electrodes may be formed on the TFT substrate including the channel layer 304 of the active layer 304a and the ohmic contact layers 304b, and then patterned by photolithographic processes to form the source/drain electrodes 305 and the data line 306.

[0075] In FIG. 4c, a passivation film 307 of an inorganic material may be deposited on an entire surface of the TFT substrate to protect a plurality of stacked devices. Then, a contact hole may be formed in the passivation film 307 to provide electrical contact for a connection with a pixel electrode to be formed within a pixel region of the passivation film 307.(S403)

[0076] A process of forming the contact hole may include steps of coating a photoresist on the passivation film 307, forming a photoresist pattern using photolithographic

processes, etching portions of the passivation film using the photoresist pattern as a mask, and removing the portions of the photoresist pattern.

[0077] In FIG. 4d, a step of forming a compensation film 308 at the subsequently formed pixel region on the passivation film 307 in which the contact hole may be formed.(S404)

[0078] The compensation film 308 may not be formed during the previous step due to its chemical structure weak in heat. Specifically, the processes performed prior to forming the compensation film 308 are carried out at high temperatures of 230°C to 320°C for an extended period of time, thereby decomposing polymers of the compensation film 308 and abruptly lower light transmittance of the liquid crystal display device.

[0079] The compensation film 308 is formed prior to steps of forming the pixel electrode. Therefore, a problem in the thermal stability of the compensation film 308 is minimized when the compensation film 308 is formed, because the deposition temperature of the ITO pixel electrode is lower than that of other materials.

[0080] In FIG. 4e, the pixel electrode 309, which may be formed of indium tin oxide (ITO), may be formed in the contact hole of the passivation film 307 and on the compensation film 308.(S405)

[0081] FIG. 5 is a view showing a structure of an exemplary color filter substrate according to the present invention. As shown in FIG. 5, a color filter substrate may include a transparent insulating substrate 501, a black matrix 502 formed by depositing a metal film of chromium (Cr) on the transparent insulating film 501, a color filter layer 503 formed by sequentially forming red, green, and blue color photoresist films on the black matrix 502 and exposing and developing the coated red, green, and blue photoresist films, a compensation film 504 formed on the color filter substrate upon which the color filter layer 503 has been previously formed, and a common electrode 505 formed by depositing a metal film of ITO on the color filter substrate upon which the compensation film 504 has been previously formed.

[0082] A fabrication method of a LCD device with a compensation film in inner side of a substrate in accordance with the present invention, in association with FIG. 5, will be described.

[0083] FIGs. 6a to 6d are views showing a structure of an exemplary method for fabricating a second substrate (a color filter substrate) according the present invention. In FIGs. 10 to 13, a color filter layer may be formed by different methods that include dyeing, dye dispersion, pigment dispersion, and electrode-position. Accordingly, in FIGs. 10 to 13, the exemplary method includes the pigment dispersion method.

[0084] In FIG. 6a, a step of forming a black matrix (BM) 502 includes depositing a metal film of chromium on a transparent insulating substrate 501.(S601) Alternatively, another method may include depositing a photoresist film containing carbon black and titanium oxide, which have light-shielding properties, on the transparent insulating substrate 501. Then, portions of the photoresist film may be exposed to light using a mask to form a predetermined photoresist pattern. Then, the photoresist film may be developed to remove the exposed portions of the photoresist film, wherein remaining

portions of the photoresist film pattern after the developing process may be hardened to form the black matrix 502.

[0085] As shown in FIG. 6b, a red photoresist film may be coated on the black matrix 502, exposed to light, and developed to form a red color filter layer.(S602)

[0086] In detail, a photoresist film of azo-based red pigment may be coated on the transparent insulating substrate 501 upon which the black matrix (BM) 502 has been previously formed, and portions of the photoresist film may be exposed to light using a mask to form a predetermined photoresist pattern. Then, the photoresist film may be developed to remove the exposed portions of the photoresist film, wherein portions of photoresist film may be hardened to form a red color filter layer.

[0087] Using the same method, green and blue color filter layers may be sequentially formed on the transparent insulating substrate 501.(S603) a photoresist film of phthalocyanine-based green pigment may be coated on the transparent insulating substrate upon which the red color layer has been previously formed, and portions of the photoresist film may be exposed to light using a mask to form a predetermined

photoresist pattern. Then, the photoresist film may be developed to remove the exposed portions of the photoresist film, wherein portions of photoresist film may be hardened to form a green color filter layer.

[0088] Furthermore, a photoresist film of phthalocyanine-based blue pigment may be coated on the transparent insulating substrate upon which the red color layer has been previously formed, and portions of the photoresist film may be exposed to light using a mask to form a predetermined photoresist pattern. Then, the photoresist film may be developed to remove the exposed portions of the photoresist film, wherein portions of photoresist film may be hardened to form a blue color filter layer. Thus, the color filter layer 503 may be formed.

[0089] FIG. 6c shows a step of forming a compensation film 504 on the transparent insulating substrate 501 upon which the red, green, and blue color filter layers 503 have been previously formed.(S604)

[0090] However, the compensation film 504 may not be formed in during previous steps due to its chemical structure weak in heat. Specifically, the processes prior to forming

the compensation film 504 may be performed at high temperatures of 230°C to 320°C for an extended period of time. Accordingly, polymers of the compensation film 504 may decomposed, thereby abruptly lowering light transmittance of the liquid crystal display device.

[0091] The compensation film 504 is formed prior to steps of forming the common electrode. Therefore, a problem in the thermal stability of the compensation film 504 is minimized when the compensation film is formed, because the deposition temperature of the ITO common electrode is lower than that of other materials.

[0092] In FIG. 6d, a step of forming the common electrode 505 on the transparent insulating substrate 501 upon which the compensation film 504 has been previously formed may include depositing an ITO metal film, which is a transparent conductive film, on an entire surface of the transparent insulating substrate 501.

[0093] FIG. 7 is a view showing a structure of another exemplary second substrate (color filter substrate) according to the present invention. As shown in FIG. 7, a color filter substrate may further include an overcoat film 506 formed on the red, green, and blue

color filter layers 503. The overcoat film 506 allows a planarization and a adhesive power between the color filter layer 503 and the compensation film 504 to be enhanced.

[0094] Since only the compensation film is formed in inner side of the substrate without the protection film and adhesion film as the above, the LCD device with compensation film in inner side of the substrate can be fabricated to have a lowest profile.

[0095] It will be apparent to those skilled in the art that various modifications and variations can be made in the liquid crystal display device and method of fabricating a liquid crystal display device of the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

【Effect of the invention】

[0096] As the described above, because the compensation film is formed in inner side of substrate through a depositing process, the LCD device according to the present invention has a thin thickness.

【What is claimed is】

1. A liquid crystal display device, comprising:

a gate line and a gate electrode formed on a transparent insulating substrate by coating process of a gate metal film;

a gate insulating film, an active layer, an ohmic contact layer, source and drain electrodes, and a data line formed sequentially on the transparent insulating substrate;

a passivation film formed on the transparent insulating substrate including the source and drain electrodes and the data line;

a compensation film formed on the passivation film; and

a ITO pixel electrode formed on the compensation film.

2. A method of fabricating a liquid crystal display device, comprising:

forming a gate line and a gate electrode on a transparent insulating substrate by coating process of a gate metal film;

forming sequentially a gate insulating film, an active layer, an ohmic contact layer, source and drain electrodes, and a data line on the transparent insulating substrate;

coating a passivation film for a element protection on the transparent insulating substrate including the source and drain electrodes and the data line;

forming a compensation film on the passivation film; and

forming a ITO pixel electrode on the compensation film.

3. A liquid crystal display device, comprising:

a black matrix formed on a transparent insulating substrate;

a color filter layer, which has red, green and blue colors, formed on the black matrix through sequential coating, exposing and developing for each of red, green and blue colors;

a compensation film formed on the color filter layer; and

a common electrode formed on the compensation film by a depositing process of ITO metal film.

4. The device according to claim 4, further comprising an overcoat film formed on the substrate having the color filter layer.

5. A method of fabricating a liquid crystal display, comprising:

forming a black matrix on a transparent insulating substrate;

forming red, green and blue color layers on the black matrix by a process of sequential coating, exposing and developing for each of red, green and blue color layers,

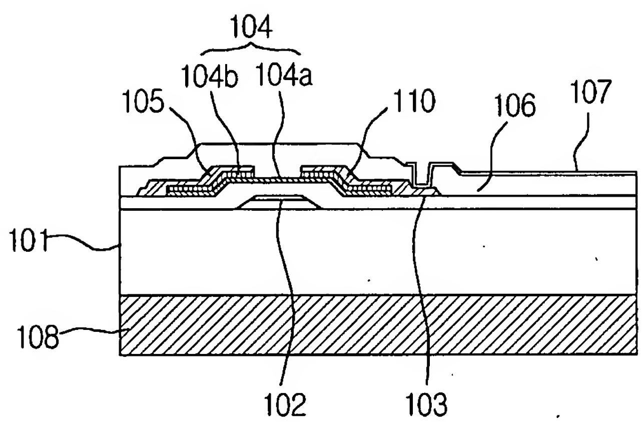
forming a compensation film on an upper surface of the red, green and blue color layer; and

forming a common electrode on the compensation film through a process of depositing a ITO metal film.

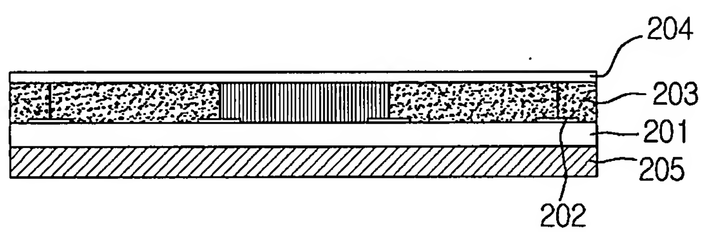
6. The method according to claim 5, further comprising forming a overcoat layer on the substrate with the color filter layer.

【Drawings】

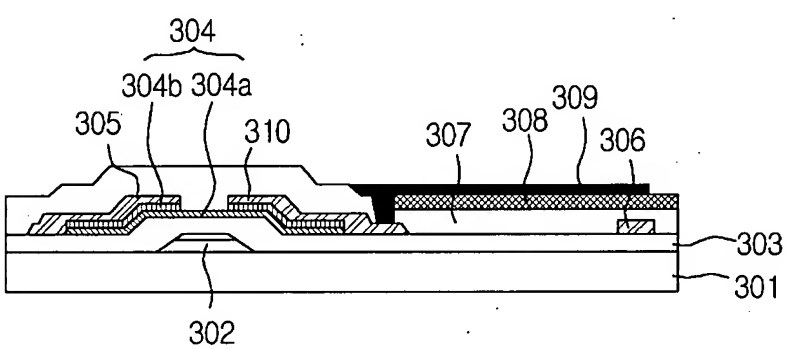
【Fig. 1】



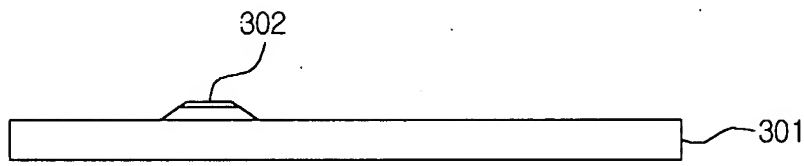
【Fig.2】



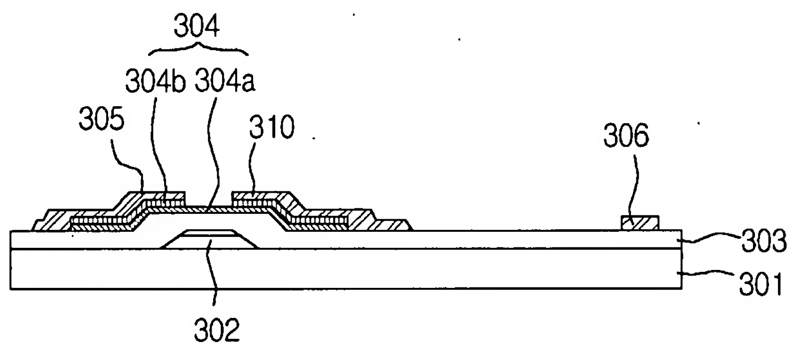
【Fig. 3】



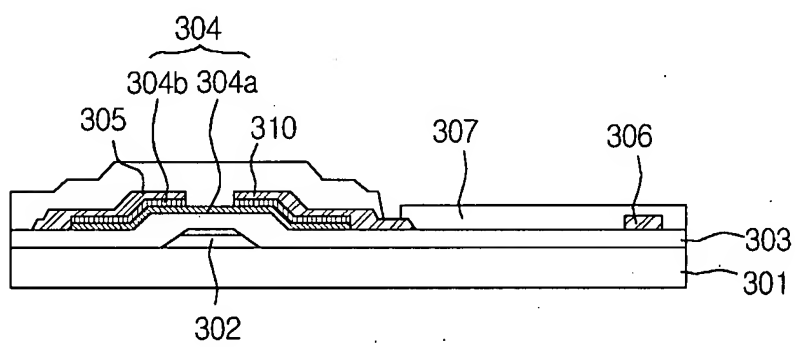
【Fig. 4a】



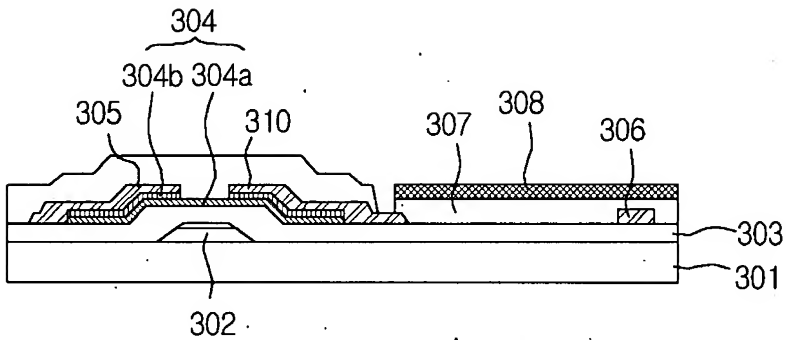
【Fig. 4b】



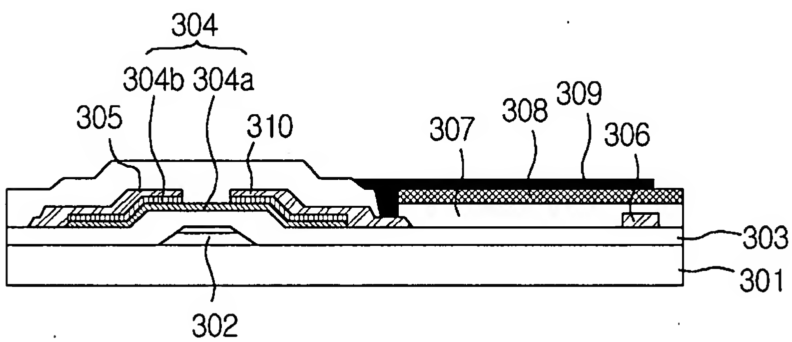
【Fig. 4c】



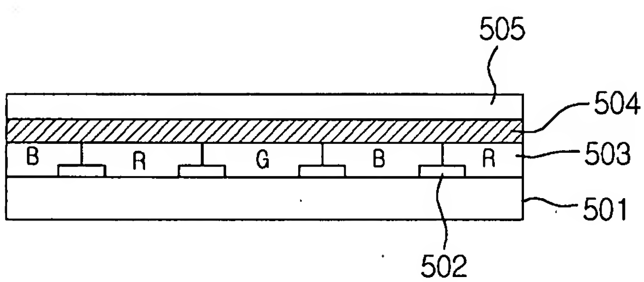
【Fig. 4d】



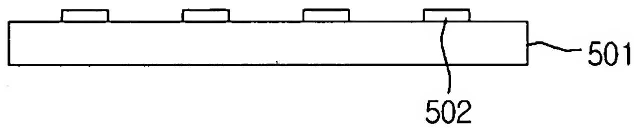
【Fig. 4e】



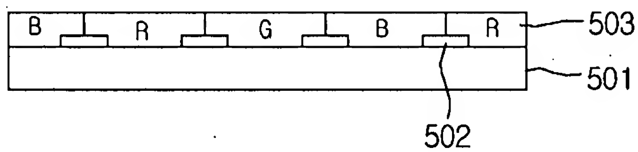
【Fig. 5】



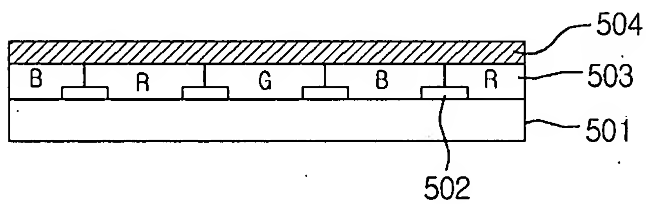
【Fig. 6a】



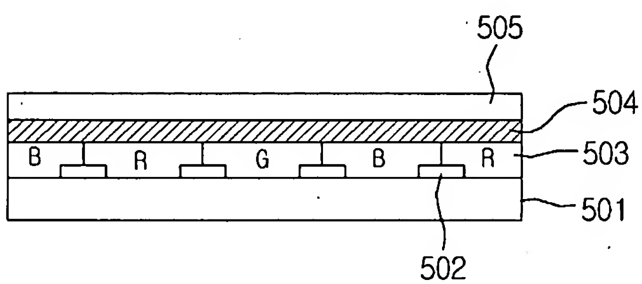
【Fig. 6b】



【Fig. 6c】



【Fig. 6d】



【Fig. 7】